Blackberry Creek Daylighting Project, Berkeley: Ten-Year Post-Project Appraisal

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Landscape Architecture 227, Fall 2005, Professor Matt Kondolf

Final Draft

Abstract
Blackberry Creek drains a 0.3-square-mile watershed, flowing from the northeastern hills of Berkeley, California into the Marin Creek culvert and then to the San Francisco Bay. A 200-foot reach running under Thousand Oaks Elementary School was daylighted in 1995 by Wolfe Mason Associates in collaboration with the Urban Creeks Council. The goals were to provide an outdoor science lab for the school and an alternative to a culvert with a history of flooding.

Post-project appraisals conducted in 1996 and 2000 focused on geomorphic and biological aspects, and found sufficient flood control capacity and greater density of riparian vegetation than envisioned in project design. We conducted a PPA ten years after project completion, surveying the longitudinal profile and two cross sections of the creek. We also looked at historical rainfall data and identified a 10-year event in 2002. Comparing our data to previous PPAs, channel flood capacity and gradient appear stable although the channel itself may have migrated within the high bankfull. Bank vegetation has become even denser, reflecting a lack of maintenance.

Previous PPAs documented tension relating to perceived use and design among diverse groups such as the School, the Neighborhood Association, and a Tai Chi group that used the park and tot lot. To get a sense of community perception and use ten years post-project, we interviewed the Thousand Oaks science teacher, past and current presidents of the Thousand Oaks Neighborhood Association, and the chair of the Urban Creeks Council at the time of daylighting. Today, the school is using the site as a regular science lab and the initial tension seems to have dissipated into general public acceptance.

Introduction and Project Background

The daylighting of waterways has been an emerging phenomenon since the late 1970s, but remains relatively new. In 1995, Blackberry Creek, the subject of this post-project appraisal, was the third urban creek to be daylighted in Berkeley, and the first to be daylighted on school grounds.

Blackberry Creek drains a 0.3-square-mile watershed and runs from the northeastern hills of Berkeley, CA to the San Francisco Bay. It was historically a tributary of Middle Creek until the 1940's-60's, when the City of Berkeley buried portions of it for urban development and redirected it into a culvert of Marin Creek (see Figure 1). Pre-restoration, Blackberry Creek entered a culvert upstream of the daylighted reach and ran under Thousand Oaks Elementary School (see Figure 2). This culvert had a history of flooding during large storms. The Loma Prieta earthquake in 1989 damaged Thousand Oaks and other facilities of the Berkeley Unified School District, and when the school's turn for structural upgrades came in 1992, the Parent Teacher Association (PTA) proposed the idea of daylighting the creek in order to mitigate flooding and integrate the creek with the school's science curriculum.

Together with the Urban Creeks Council (UCC), the PTA applied for a grant from the California Department of Water Resources (CDWR) Urban Stream Restoration Program to daylight the creek. UCC and the PTA originally planned to daylight the entire reach of flowing through Thousand Oaks. CDWR awarded them $144,000, approximately $50,000 less than requested, to daylight a smaller reach that ran under the western portion of the schoolyard, called the Grove (Bronstein, personal communication, 2005). Wolfe Mason Associates (WMA) was contracted to perform the work and started the restoration process with UCC in 1995, grading the bank and creating 189 feet of new channel.

Because the creek ran through a residential neighborhood and under an elementary school, the daylighting process significantly affected the community, acting as both a source of tension and solidarity. WMA had to compromise design specifications with community preferences, for example leaving a redwood tree designated for removal because it was the meditation tree of a local Tai Chi group and shortening the reach of the creek from the 250 feet that was originally planned (Askew, 1996). Also, the daylighting entailed the removal of a widely used tot lot (see Figures 3 and 4), and due to objections by community members, the Thousand Oaks school board mandated that $25,000 of the CDWR grant be allocated towards constructing a new one (Bronstein, personal communication, 2005).

The daylighted creek was contaminated with sewage after the daylighting, rendering it inaccessible until 2003. The Thousand Oak's science teacher used this as an opportunity to teach about local politics, and students successfully lobbied to investigate the source of contamination. Today, the school uses the creek as the outdoor science classroom as there is no longer an indoor science classroom (Bindloss, personal communication, 2005), and the local community uses it and the surrounding park for recreation (see Table 1 for timeline of events).

Objectives of the ten-year Post-Project Appraisal (PPA)

Our objective of conducting a ten-year post-project appraisal (PPA) is to provide a decade-long view of the project's life. Past appraisals conducted one year post-project in 1996 (Askew, 1996) and five years post-project in 2000 (Imanishi, 2000) focused primarily on geomorphic and biological aspects (see Table 2 for conclusions from past PPAs). We also investigated these aspects, but expand upon social impacts due to the urban context of the daylighting project. We are interested not only in investigating how the channel changed in the past 10 years, but also in how it involved and influenced the local community. The former may inform the design of future urban creek restoration projects, and the latter may inform community involvement in future restoration projects involving small urban creeks.

Methods

Survey of Channel Form and Geomorphology

On November 12, 2005, we surveyed the longitudinal profile of the creek's thalweg and profiles of its cross sections using an automatic level, paying particular attention to pools and riffles in the channel. We then recorded elevation and water depth at each change in gradient. The 1996 appraisal surveyed cross sections at 4 documented points, and the 2000 appraisal at points 1 and 3 (in an upstream-to-downstream order). Previous PPAs did not explicitly describe but one cross section permanent monument, so we estimated the cross sections' exact locations to the best of our ability (see Appendix A). We surveyed cross sections at points 3 (a riffle at Station 1+25) and 4 (a pool at Station 1+65) because we wanted one point that was consistent across all appraisals (point 3) and another that was not constructed by the 2000 appraisal (point 4) and to observe profile at a riffle and at a pool. We intended to survey cross sections for all 4 points, but the vegetation was so dense that surveying was difficult (see Figure 5). We then tabulated raw survey data and plotted elevation against distance from a specific point for each of the profiles. We returned to the creek on December 2, 2005 because we discovered a survey problem with both cross sections, but still could not identify their exact locations and obtained elevations similar to those from our first survey.

Rainfall data

We obtained historical daily rainfall data from 1995 to 2005 to identify storms of substantial size. Analysis of these data alongside channel form data revealed the likely effect of large storms and therefore water volume on channel bank erosion and downcutting. While the 1996 PPA used maximum monthly rainfall intensity calculated for 15 and 30 minutes (measured in inches/hour), the 2000 PPA looked at daily rainfall data converted into 1-day intensity figures (measured in inches/day). We requested the former type – our preferred type – but Alameda County Flood Control and Water Conservation District could only provide data on maximum daily rainfall for the UC Botanical Gardens. We listed storms greater than 2 years in RI and noted any 10-year storm.

Vegetation

We did not focus our study on riparian vegetation, but wanted to report on its current density and state. In November 12, we noted visual observations about the vegetation at the creek. On our second day of field work, December 2, 2005, we surveyed the creek's density with a densiometer. Closely following the use protocol from the Regional Water Quality Control Board (Appendix B), we evaluated percentage of canopy cover. Qualitatively, we noted how much light penetrated the vegetative canopy and took photographs to document our observations.

Community Perception and Use

We conducted four interviews to gain a sense of community perception and use of the daylighted creek. We interviewed Jon Bindloss, the Thousand Oaks fourth grade science teacher, to learn how the school is currently using the creek park, how students seem to perceive and respond to the creek park both during and out of class, and if perception and use among teachers and/or students have changed since project completion. We also interviewed Zelda Bronstein and Zippie Collins, former and current presidents of the Thousand Oaks Neighborhood Association (TONA), respectively, to gain a longer-term view of community perceptions regarding the restoration project. Finally, we interviewed Carole Schemmerling, the chair of the Urban Creeks Council at the time of the daylighting. We also talked to Lisa Carrona, the project manager at the City of Berkeley.

Photomonitoring

We took photographs from the same two photo points as documented in former PPAs (see Appendix A) to help visualize how the channel changed over time. We also photographed a meandering strip of concrete on the eastern portion of the playground to show where the creek still flows under the school.

Pre-Project Considerations

Success Criteria

This PPA considers project performance based on two sets of stated goals, namely geomorphic and social. The 1996 PPA documented the project's geomorphic goals to be channel stability and flood containment. Located in an urban residential area, flood management was an important goal and the City's Engineering Department specifically required the project to not reduce the 145 cfs inflow capacity of the outlet culvert (Askew, 1996). Various articles also pointed out the culvert's history of flooding nearby streets (Pinkham, 2000).

In addition to the outdoor science classroom, the project intended to allow neighbors access to the creek. These two goals of Blackberry Creek Daylighting Project were particularly relevant in meeting the "public education and outreach" and "public participation and involvement" mandates of Phase II of the National Pollutant Discharge Elimination System (Pinkham, 2000) which identified non-point source runoff pollution as the main cause of water quality degradation in urban areas.

Design Rationale

Ann Riley, the project hydrologist, based the channel geometry design on several considerations including the Dunne-Leopold regional relationship for a watershed area of 0.3 square miles. In addition, she investigated a stable upstream segment as well as historical aerial photographs to inform the final channel design. The restored channel was built to be 8 feet wide and contain water up to 1.5 feet deep. A summer low-flow channel was excavated within the 8-foot wide channel, measuring 2 feet in width and 0.5 feet deep. Native plant fascines and erosion control fabric would promote channel stability in this dense residential area (Askew, 1996).

The design process also had to take public input into account. The project design originally proposed 250 feet of channel, but a local Tai-Chi club wanted an old redwood tree to remain on the project site. This required Riley to shorten the channel length to about 189 feet and construct four rock check dams to dissipate excess energy resulting from the shorter channel length (Askew, 1996).

Results and Discussions

Channel Form and Geomorphology

Longitudinal Profile

We compared the 2005 profile to those from 1996 and 2000 and found that grade control measures constructed during the project have been successful. All four rock check dams are still present at Stations 0+40, 0+80, 1+13, and 1+58. Channel gradient seems stable with minor accretion and downcutting (see Figure 6).

Sediment deposition just upstream of the dam 38 feet from the upstream culvert resulted in sediment accretion of 0.7 feet from 2000 figures and of 1.2 feet from 1996 figures. Elevation then remains stable for about 25 feet downstream before downcutting begins at about 65 feet from the upstream culvert. We observed downcutting of up to 0.5 feet (from 1996 and 2000 figures) in the next 45 feet of channel. We found the channel bed stable and slightly aggrading below the third rock check dam at 113 feet from the upstream culvert. The channel bed takes a small dip of about 0.3 feet before entering the downstream culvert.

The channel also displayed more pools and riffles than observed in past PPAs. The 1996 PPA documented two riffles and four pools (Askew, 1996), the 2000 PPA found seven riffles and six pools (Imanishi, 2000), while our long profile shows at least nine riffles and seven pools. This increase in pools and riffles is evidence that the channel gradient is stabilizing and the grade control structures are therefore performing well.

At Station 0+44.7, there appears to be unreliable data. We observed a pool immediately below the first rock check dam, with water 1 foot deep. However, the bed elevation as observed in the data was not low enough such that the water level is seen to be "jumping up" (see Figure 6). We decided that the bed elevation should have been similar to the two PPAs, at about 89.6 feet.

Cross Sections

From the two cross sections we surveyed, the channel appears to have migrated towards the right bank over the decade. At Cross Section 3, the channel's thalweg appears to have moved by about 5 feet towards the right bank, and at cross Section 4 (Station 1+65) by 3.1 feet towards the right bank (see Figures 7a and 8). Such migration is unlikely considering the stream size and rainfall data, and we deem it an artifact of inconsistent surveying. We made a second attempt to survey these cross sections, but without certainty as to cross section locations, were unable to produce meaningful results (see Methods section above). Since the channel shape appears to have remained relatively constant, we conclude that the channel geometry has not changed significantly (Figure 7b and 8). However, rainfall data below may shed light on the amount of rain the site experienced between the 2000 and current surveys.

Visually, we observed more pronounced bank erosion in the middle reach where the channel is more accessible by people than in the lower reach where there is less direct access. The right bank also suffered more erosion, perhaps because stairs leading down from the park's footpath in turn allowed for easier access.

<u>Rainfall Data</u>

Table 2 is a list all events of rainfall intensity greater than the 2-year interval between 1995 and 2005, while Table 3 is the recurrence interval for Alameda County storms. We noted one incidence of a 10-year event, followed the next day by a 2-year event in December 2002. This is the first 10-year event since the project was completed (Askew, 1996; Imanishi, 2000), and the 2-year event might have led to some bank erosion (Figure 9). While the channel appears stable over the first 5 years, the substantial migration of the channel as observed in the cross sections above might be attributed to this storm of unprecedented intensity. Nonetheless, this relationship is an interesting but untested hypothesis. According to the City of Berkeley's project manager, Lisa Carrona, the creek has not so far overflowed its banks.

Summary of Data Variability from Past PPAs

Our cross section surveys were inconsistent with those from 1996 and 2000 PPAs. First, we could not construct all four cross sections surveyed in the 1996 PPA; instead, we constructed Cross Sections 3 and 4. Second, Cross Section 3 had one permanent monument on its left bank used in past PPAs, but the 1996 PPA marked explicitly neither the cross section line itself nor the end point at the other side of the bank (see Appendix A). We attempted twice to survey a cross section profile perpendicular to the channel at both cross section points. Our raw survey data indicate substantial – but perhaps unrealistic – channel migration and bank movement (both deposition and erosion) when related to 1996 and 2000 figures, suggesting different cross section locations and/or alignments were surveyed. Although the starting point and station were the same for this cross section, we doubt the consistency in terms of alignment of the cross section line. Slight changes in the channel's banks also made it difficult to survey cross sections at identical locations and alignments. Finally, there is also variability in rainfall data type and sources varied across the three surveys and this difference might have affected our findings.

Vegetation

From the photos taken in 1995, 1996, and 2000 at photo points 1 and 2 (see Appendix A for location of photo points), we noticed that the vegetative canopy has increased in height and density (see Figures 10 and 11). Our densiometer survey results are found in Table 4. We calculated canopy cover to be between 81 - 100%, a high value indicating little sunlight penetration (Figure 12). Because of this, ground cover was sparse (see Figure 13). Forest floor species that had sustained or increased in abundance from the 1996 to the 2000 PPA (e.g. Douglas' iris and Buttonbush) were not found in November of 2005. Looking at the vegetation present, we noted differences between vegetation emphasized in landscaping (e.g. sword fern; Imanishi, 2000) and that which was actually dominant (e.g. arroyo willow), and vegetation had been planted (e.g. arroyo willow; Imanishi, 2000), and that which had "invaded" (e.g. Cape Ivy). Considering these trends, we propose that overall plant diversity has decreased since the time of planting.

<u>Community Perception and Use</u>

Our conversations with individuals in the community who were involved in the project revealed some pertinent issues. They highlighted a difference between the project's *stated* goals, as decided by WMA and the UCC in collaboration with the Thousand Oaks PTA and local community, and its *perceived* goals, as interpreted by stakeholders not directly involved in the design process. We conclude that the project's stated goal of flood mitigation has been satisfied so far, judging by the fact that the creek's banks have never overflowed despite the incidence of a 10-year storm event (Tables 3a and 3b; Caronna, personal communication, 2005). We also conclude that the goal of environmental education, unsatisfied in former PPAs, has been favorably satisfied since last year, when the creek became Thousand Oak's regular science classroom (Bindloss, personal communication, 2005). Jon Bindloss, the Thousand Oak's science teacher, deemed the daylighting project a success, and commended the creek for providing hands-on experience with subject matter from aquatic biology to local politics and facilitating learning. Although students made fun of the creek when it was contaminated, he claims that they love it now (personal communication, 2005).

The project's assumed goals, however, were not satisfied initially. Firstly, because a widely used tot lot located on the daylighting site was slated for removal by the project design, then-president of TONA, Zelda Bronstein, and other community members expected it to be replaced (personal communication, 2005). However, DWR did not grant funding to replace it, and Bronstein and others pursued their own fundraising efforts. Although they successfully raised funds from neighbors and nearby businesses, the tot lot issue created tension between community members and project designers (Bronstein, personal communication, 2005). Second, the project design also called for the removal of a redwood tree in the park, which the local Tai Chi group was using as a meditation tree (see Appendix A). The day construction started, the Tai Chi group requested the tree be left standing. In this case, WMA accommodated its design plans to leave the tree by creating grade control structures to compensate for a shorter channel length.

Another issue was the discovery that the daylighted creek was contaminated with raw sewage, causing concern among the community (Bindloss, personal communication, 2005; Bronstein, personal communication, 2005). Although contamination prevented regular educational use of the creek, Thousand Oak's science teacher Jon Bindloss used the opportunity to teach students about lobbying and local politics. The students wrote to the Mayor of the City of Berkeley to investigate the source of contamination – an open sewer cap, bringing about the city's alleviation of problem. Finally, community members expected to be able to easily see and access the creek – understandable given WMA's design sketch (see Figure 14). The creek could hardly be seen once the vegetation grew too dense, resulting in aesthetic dissatisfaction and safety concerns (Collins, personal communication, 2005; Bronstein, personal communication, 2005). The City of Berkeley has conducted community outreach about the importance of canopy cover for the creek's health and vegetation for bank stability (Caronna, personal communication, 2005). According to current TONA president Zippie Collins, then-chair of the UCC Carole Schemmerling, City of Berkeley parks supervisor Douglas

MacDonald, and City of Berkeley project manager Lisa Caronna, initial community dissatisfaction with dense vegetation has dissipated into overall appreciation for the creek (Collins, personal communication, 2005; Schemmerling, personal communication, 2005; MacDonald, personal communication, 2005, Caronna, personal communication, 2005).

Summary of conclusions

- Stability of grade control structures, evidenced by increased pool-riffle sequences
- No major changes in channel geometry
- Successful flood conveyance
- 88% canopy cover
- Use as outdoor science classroom
- Overall community appreciation and use

Overall, the channel has remained stable over 10 years withstanding a 10-year RI event. Channel migration within the relatively steep flood plain did not affect its capacity to contain flood. The grade control structures remained stable, and helped stabilize channel gradient by creating more pools and riffles than observed in previous PPAs. The creek is successfully used as the Thousand Oaks science classroom. As such, the Blackberry Creek daylighting project satisfied its intended outcomes of flood mitigation and environmental education. However, the project did cause some community tension which, although has mostly dissipated into appreciation for the creek, points to the need for greater community involvement in urban creek restoration. Further, despite complaints about overgrown willows the community around the creek has come to accept the importance of vegetation in protecting water quality.

Finally, we presumed that daylighting less than 200 feet of creek in an urban context has almost negligible ecological benefit. However, this is a somewhat limited view. Blackberry Creek was one of the first urban daylighting projects, and spawned similar projects in the East Bay. Accordingly, it promoted the creation of a habitat corridor which, when considered at the East Bay regional scale, is significant. Furthermore, if small daylighting projects inspire further ones, along with environmental stewardship in general, their ecological benefits may cascade far beyond their immediate setting.

Recommendations

For Future PPAS

Although Kondolf (1996) qualify ten years as a sufficient monitoring period for a restoration project, we recommend another post-project appraisal as soon as possible. The details of the social components were lacking in previous PPAs and would be interesting to observe and expand with a representative sample size. In appraising the creek's geomorphology, we recommend that future PPAs document permanent monuments and cross section lines as precisely as possible. An example of a detailed drawing of the survey site can be found in Kondolf and Micheli, 1995 (p. 7). We recognize that the first PPA conducted plays an important role in setting the appropriate number and locations of cross sections and should clearly identify all benchmarks and monuments. The data variability we encountered resulted in somewhat inconclusive results.

However, we acknowledge obstacles despite all appreciable efforts to be consistent. Rebar and stakes may wash away, and dense vegetation may prevent accurate surveys. In Blackberry Creek's case, the 1996 PPA conducted four cross sectional surveys. By 2000, however, vegetation had grown so dense and that cross sections were impossible to construct beyond the two covered in the PPA that year (Imanishi, 2000). In 2005, despite taller canopy, it was still extremely difficult to maneuver a 13-foot survey pole in dense and bushy vegetation to conduct all four cross sections. The effect of rainfall on channel erosion would serve as supportive – but inconclusive – evidence in the case of data variability between surveys.

For Blackberry Creek

Within the immediate future, light maintenance of the site could alleviate dissatisfaction with vegetation bushiness. Pruning the willows would make the site more visually accessible and attractive. Ultimately, the creek is located in an urban park and neighbors expect a "tame" (rather than wild) place, safe for their children to play (Riley, 1998). Erosion could also pose a problem in the future. We recommend monitoring of bank stability (only as related to flood capacity) by a city technician to prevent flooding issues. We understand that our conversations were informal and sample size was not adequate to represent the Thousand Oaks community, giving us only a general pulse of how the community perceives and engages with the creek. They did reveal potential for further investigation into the project's social dimension, and we recommend that formal interviews be undertaken in future Blackberry Creek PPAs.

For Future Urban Daylighting Projects

The issues raised are salient ones in urban creek daylighting projects. As Schemmerling notes, any disturbance in a neighborhood – whether it be a temporary roadblock or the demolition of a structure – will understandably generate some degree of backlash from the local community. Although such backlash dissolves with time, it is necessary to minimize it from the beginning by actively encouraging stakeholder participation in the design process (Riley, 1998). This is especially critical in urban creek restoration because evaluations of success depend on the goals perceived by stakeholders. Early collaborations in defining project goals will build support for the project early on. Some examples of community-oriented goals and criteria for success, as we learned from the case of Blackberry Creek Daylighting Project, include:

- Degree of accessibility – how accessible is the site, and to whom?
- Degree of visibility – can the creek be seen or heard, and from where?
- Potential community uses – what can be done alongside or in the creek?

Ultimately, pre-project research of community-oriented goals is essential on a case-specific basis, and would be the seeds of successful community-based design.

Our and former PPAs evaluate the success of the Blackberry Creek daylighting project according to its stated goals of flood mitigation and environmental education; they do not evaluate the appropriateness of the goals themselves. We assumed that goal evaluation was outside the role of a PPA, but propose that it constitutes an important part of a PPA. Whether or not 'subjective' goal evaluation belongs in a PPA is debatable, but its criticality to progress in river and stream restoration is clear, as was articulated by panelists at the 2005 Berkeley River Restoration Symposium.

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Figures

Figure 1: Watershed map San Francisco East Bay, including watershed of Blackberry Creek; Daylighted reach at black triangle labeled "4" (site of Thousand Oaks Elementary School, Berkeley, CA). Source: Creek and Watershed Map of Oakland and Berkeley, 2000

Figure 2: Thousand Oaks School grounds outlined. Note residential neighborhood and commercial strip south of the school. Source: Google Earth

Figure 3: Tot Lot (viewed from west end of park, creek at bottom of stairs to the right). Note school buildings in the background; Dec 2005.

Figure 4: View of Blackberry Creek from tot lot area; 2001
Source: http://www.acme.com/jef/creeks/blackberry/

Figure 5: Dense vegetation blocking view of creek from park; Dec 2005

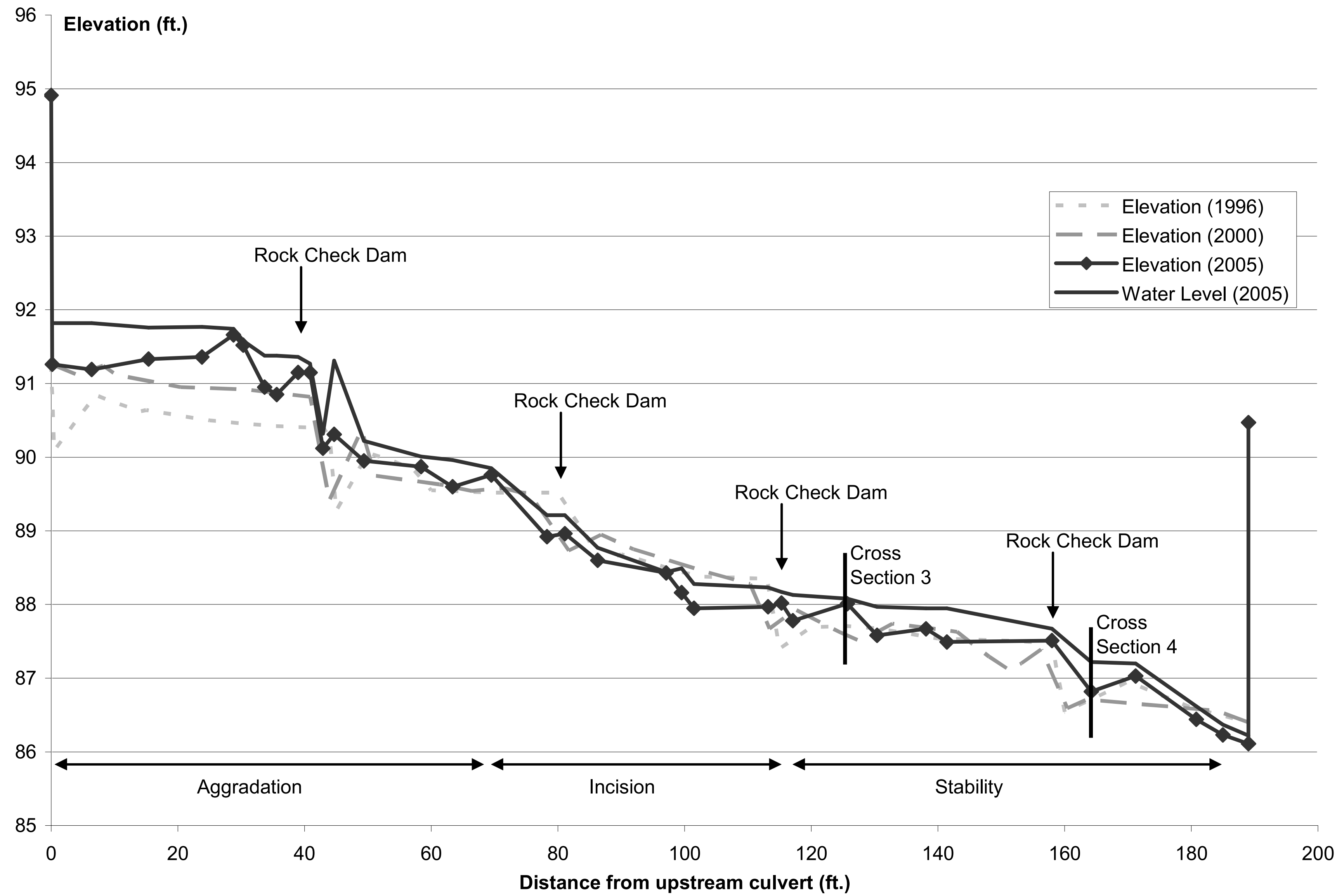


Figure 6: Longitudinal profile of Blackberry Creek; 1996, 2000, and 2005

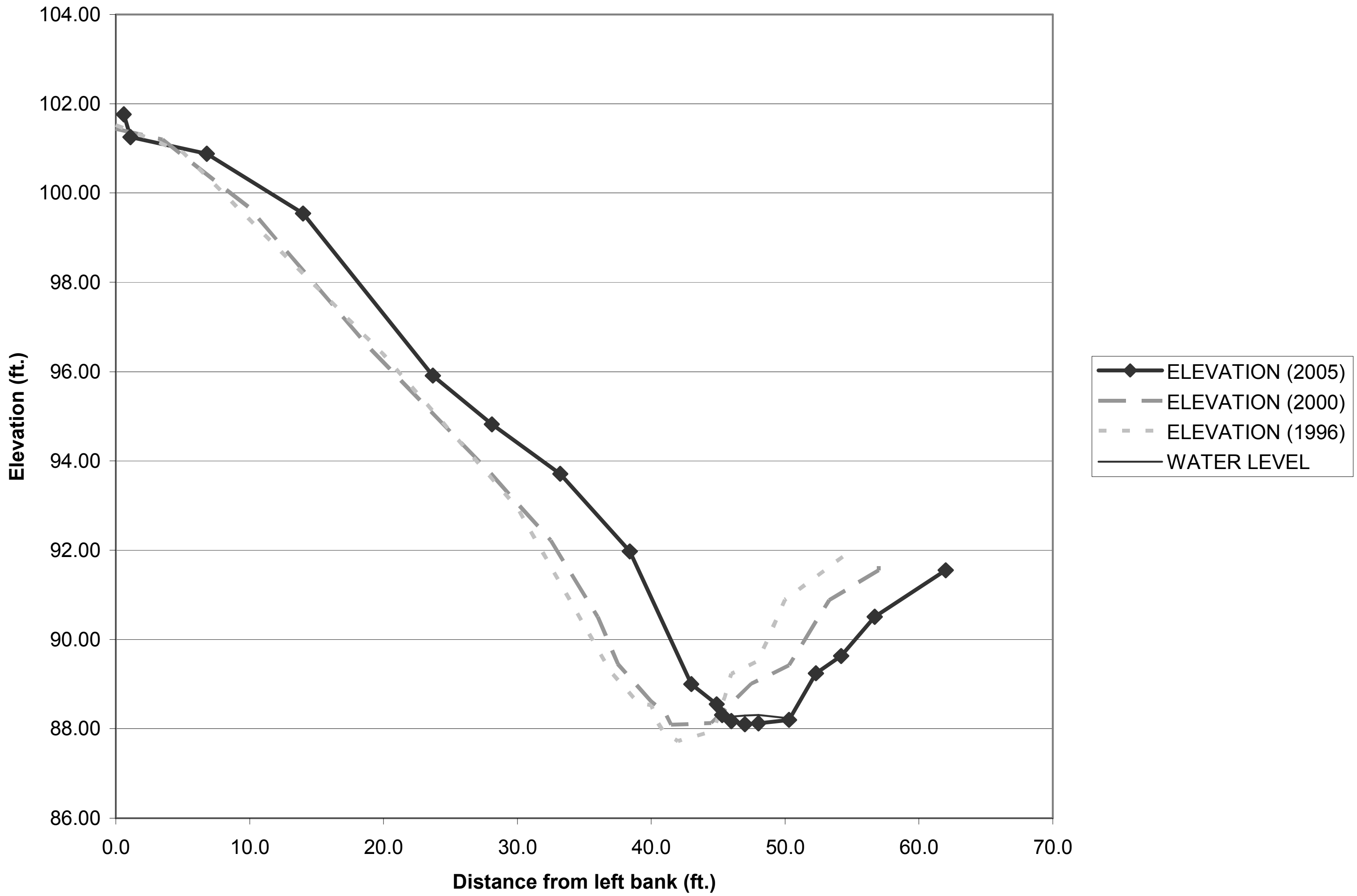


Figure 7a: Profile of Cross Section 3 (Station 1+25), facing downstream; 1996, 2000, and 2005. Note possible survey error.

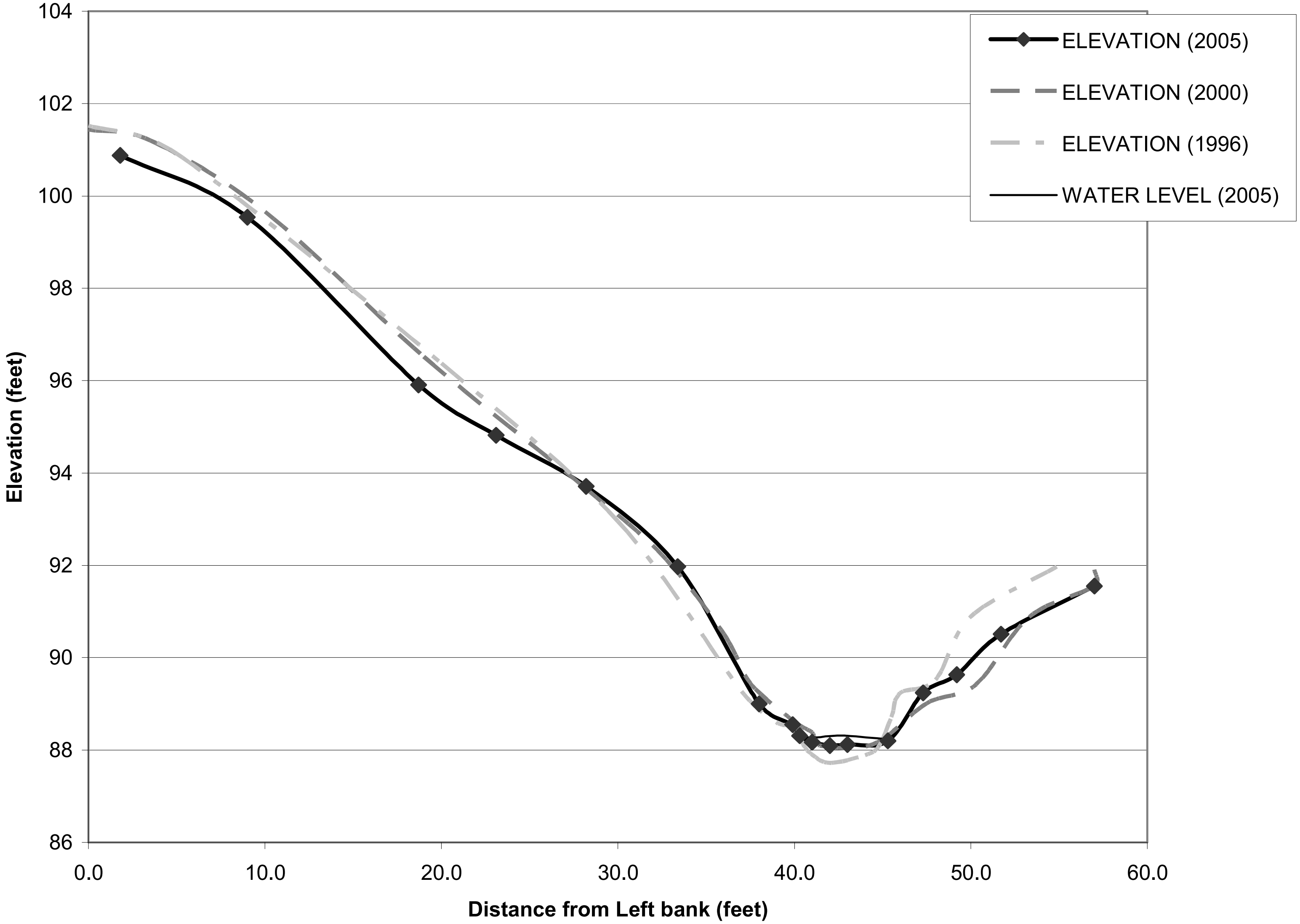


Figure 7b: Profile of Cross Section 3 (modified for possible survey error)

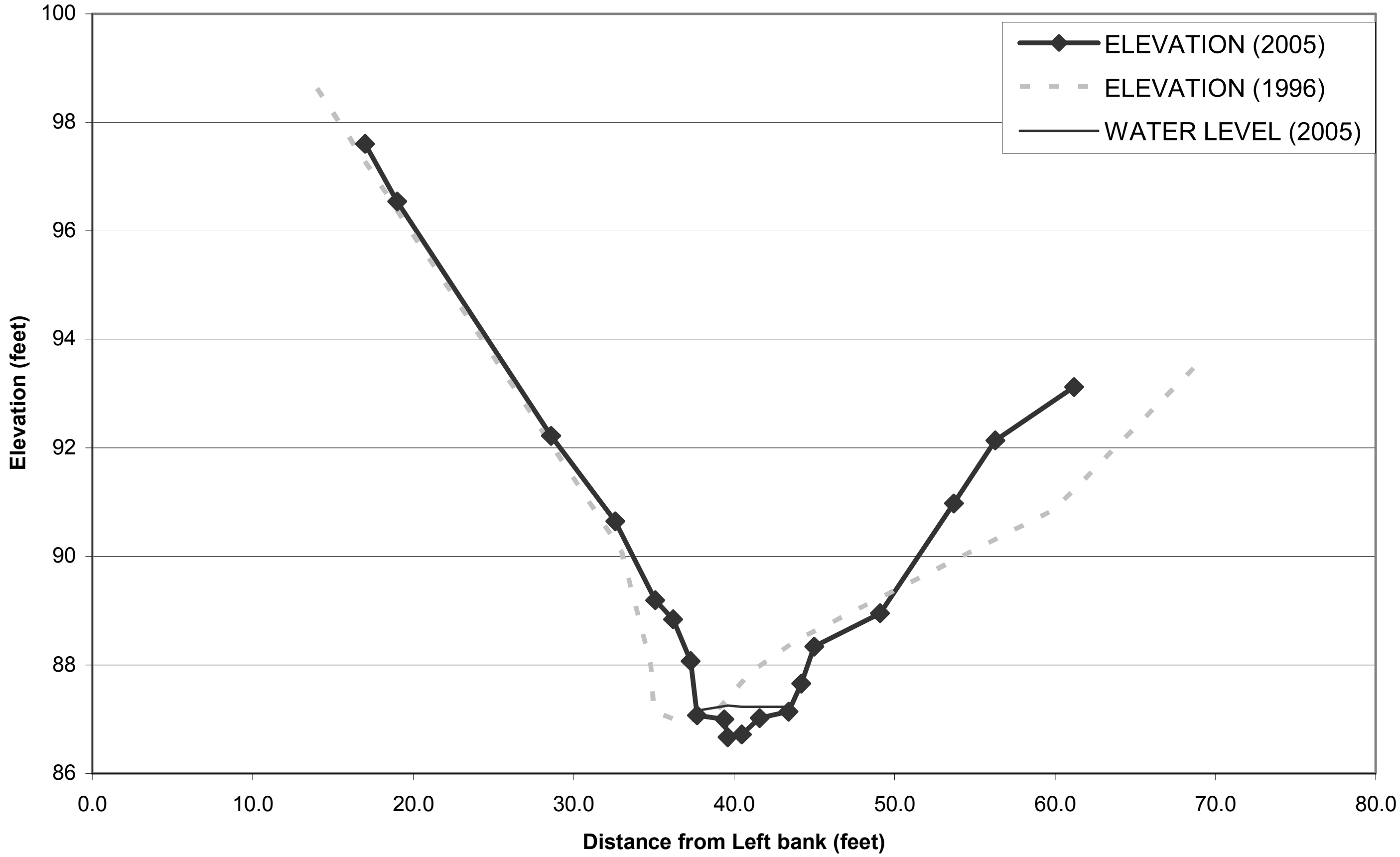
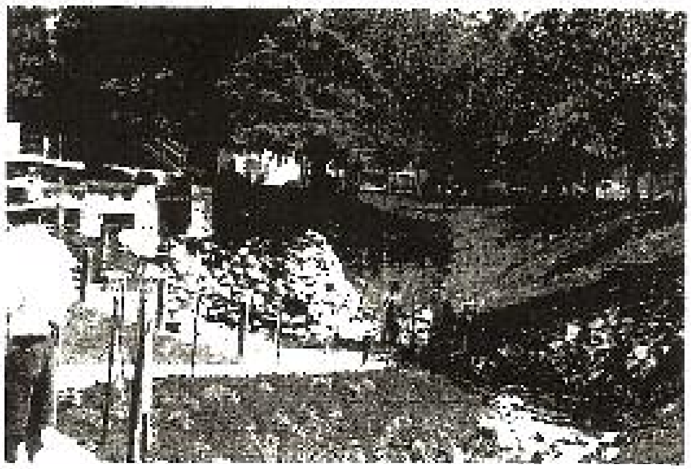
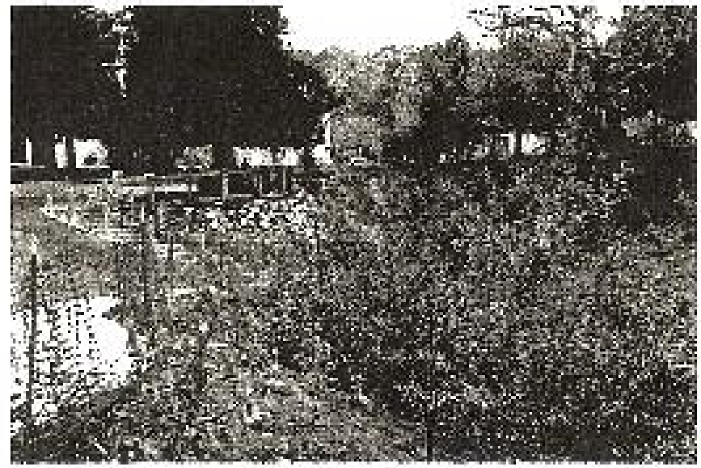


Figure 8: Profile of Cross Section 4 (Station 1+65), facing downstream: 1996 and 2005

Figure 9: Erosion of Left bank (Station 1+03 facing downstream); Dec 2005



As-Built Conditions 1995

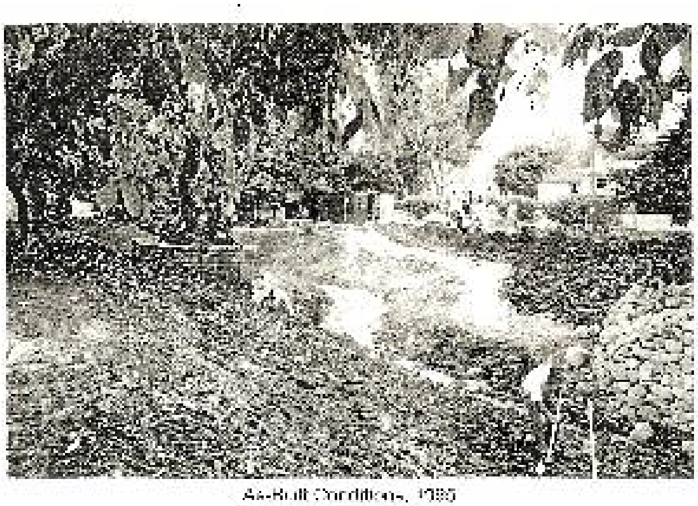


1996

2000

November 2005

Figure 10: Photo Point 1; 1995 (As-Built), 1996, 2000, and 2005. Reference feature: sidewalk.



As-Built Conditions 1995

1996

2000

November2005

Figure 11: Photo Point 2; 1995 (As-Built), 1996, 2000, and 2005. Reference feature: Stairs at right of 1996 and 2005 photos

Figure 12: Full canopy cover at Station 0+43, facing upstream; Dec 2005

Figure 13: Sparse ground cover at Station 1+65, facing Right bank, Dec 2005

Figure 14: Landscape architect's rendering of the daylighted creek – contrast with our photographs

Tables

Date	Event
1940 –1960	Blackberry Creek buried
1989	Loma Prieta earthquake
1992	Thousand Oaks PTA proposes to daylight Blackberry Creek
1994	Thousand Oaks PTA and Urban Creeks Council apply for and receive funding from California Department of Water Resources
1995	Wolfe Mason Associates performs daylighting project; creek contaminated
1996	1-year Post-Project Appraisal
2000	5-year Post-Project Appraisal
2004	Contamination arrested, creek officially reopened
2005	10-year Post-Project Appraisal

Table 1. Timeline of events

PPA	Conclusions
Askew, 1996	• Stability of grade control structures • Developed pool-riffle sequences and point bars • Bank full channel width 6.5-7 ft. and depth 0.43-1.15 ft. • No major changes in channel geometry • 95% establishment of riparian plantings • Ongoing complaints of aesthetics of dense vegetation • Neighborhood maintenance should continue
Imanishi, 2000	• Disparity of success in riparian plantings (some much more successful than others) • No major changes in channel geometry • High levels of use and stewardship • Ongoing complaints of aesthetics and safety of dense vegetation • Presence of exotic species increasing • Vegetation should be thinned, exotics removed, and access steps added

Table 2. Conclusions of 1996 and 2000 PPAs

Date	Precipitation (inches)	Return interval
12/11/1995	3.77	5 year
2/4/1996	2.53	2 year
1/1/1997	2.78	2 year
2/2/1998	2.87	2 year
2/13/2000	3.20	5 year
12/14/2002	4.24	10 year
12/16/2002	2.45	2 year
12/29/2003	3.03	2 year
2/19/2004	2.60	2 year
Source: Alameda County Public Works Department		

Table 3a: Daily rainfall intensity of Q2 events or greater at Berkeley, CA; October 1995 to October 2005. Source: National Oceanic and Atmosphere Administration; Alameda County Public Works Department

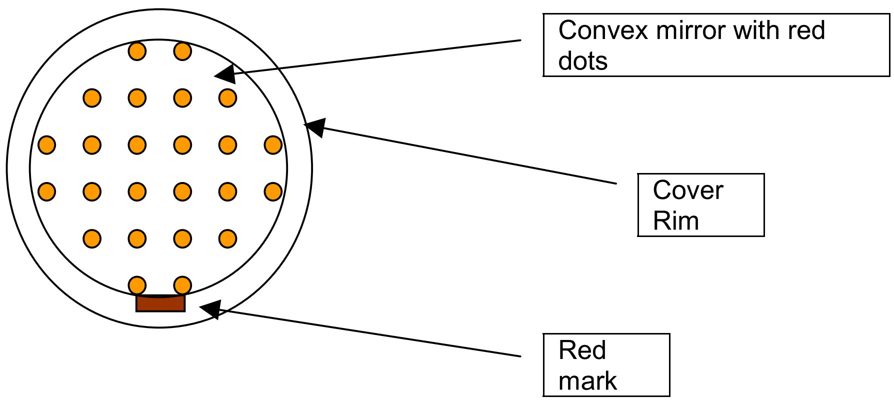
Return period (years)	1-Day Rainfall (Inches)
2	2.26
5	3.19
10	3.81
20	4.39
25	4.58
40	4.95
50	5.13
100	5.68
200	6.21
1000	7.41

Table 3b: Recurrence Interval of Rainfall Events at Berkeley, California. Source: Alameda County Public Works Department

Location	# of dots covered	*4 = % canopy cover
Station 0+43	22	88
Station 1+03	23	92
Station 1+25	19	76
Station 1+65	20	80
Average of 4 stations		84

Table 4: Results of Densiometer Canopy Survey; Dec 2005

Appendix B - Shade and Canopy Cover (SCC) Estimation Device



1. Stand in the thalweg (if possible)
   or towards the center of the creek (if not)
2. Face upstream
3. Hold the device in horizontal orientation, at chest height
4. Extend your hand forward till your forehead falls on the red
   mark on the rim at the front edge of the mirror cover
5. Count the number of dots covered by shade elements
   * Lacy canopy is counted as cover
   * Dots falling within holes in the canopy are counted as
     non-cover if the hole is dot size or larger.
6. Multiply the number of covered dots by 4; this is your
   estimated percent shade and canopy cover.
7. If you need to report shade and canopy cover in numeric
   range categories, assign your Result to one of the options
   given in your protocol or create five categories at 20% intervals
   (0-20%, 21-40%, 41-60%, 61-80%, and 81-100%)

Note: The mirror shows an imperfect hemisphere (this is a normal property of the densiometer), and you may get a different results looking downstream (or sideways).

Source: Regional Water Quality Control Board

Appendix C: Raw Survey Data – Longitudinal Profile					
STATION	**BACKSHOT**	**FORESHOT**	**ELEVA-TION (2005)**	**DESCRIPTION**	**WATER ~~WATER LEVEL~~DEPTH**
0+00	1.69		94.96	Top of US culvert	
0+00		5.34	91.26	Bottom of culvert, Top of pool	0.56
0+06		5.41	91.19		0.63
0+15		5.27	91.33		0.43
0+24		5.24	91.36		0.41
0+29		4.94	91.66	Top of riffle	0.08
0+30		5.08	91.52	Mid-riffle	0.06
0+34		5.65	90.95	Bottom of riffle	0.43
0+36		5.75	90.85	Pool	0.53
0+39		5.45	91.15	Riffle above rock check dam	0.21
0+41		5.45	91.15	Top of rock check dam	0.12
0+43		6.48	90.12	Bottom of rock check dam	0.2
0+45		6.29	90.31	Pool	1
0+50		6.65	89.95	Top of riffle	0.27
0+58		6.73	89.87	Bottom of riffle	0.14
0+63		7	89.60	Pool	0.36
0+70		6.84	89.76	Top of riffle	0.09
0+70	6.58				
0+78		7.42	88.92	Bottom of riffle, stepping stone access	0.29
0+81		7.38	88.96	Top of check dam	0.25
0+86		7.74	88.60	riffly	0.17
0+97		7.91	88.43	Top of riffle	0.01
0+00		8.18	88.16	Dip before riffle	0.33
1+02		8.39	87.95	Silt dam (natural)	0.33
1+13		8.37	87.97	Top rock check dam	0.26
1+15		8.32	88.02	Rock bottom	0.15
1+17		8.56	87.78	Pool	0.35
1+26		8.33	88.01	Riffle	0.07
1+30		8.76	87.58	Pool	0.39
1+38		8.67	87.67	Same pool	0.28
1+41		8.85	87.49	Same pool	0.46
1+41	10.2				
1+58		10.18	87.51	Top of riffle	0.16
1+64		10.87	86.82	Bottom of riffle, top of pool	0.4
1+71		10.66	87.03	Top of riffle	0.17
1+81		11.25	86.44	Pool	0.18
1+85		11.46	86.23	Riffle next to culvert	0.14
1+89		11.58	86.11	Bottom of DS culvert	0.11
1+89		7.22	90.47	Top of DS culvert	

Appendix D: Raw Survey Data - Cross Section 3 at Station 1+25					
STATION	DISTANCE	BACKSHOT	FORESHOT	ELEVATION (2005)	DESCRIPTION
0+00.6	0.6		3.59	101.76	Bottom of concrete curb
0+01.1	1.1		4.10	101.25	
0+06.8	6.8		4.47	100.88	
0+14	14.0		5.81	99.54	
0+23.7	23.7	9.44			
0+23.7	23.7		2.53	95.91	
0+28.1	28.1		3.62	94.82	
0+33.2	33.2		4.73	93.71	
0+38.4	38.4		6.47	91.97	
0+43	43.0		9.44	89.00	
0+44.9	44.9		9.89	88.55	
0+45.3	45.3		10.13	88.31	Left wetted channel
0+46	46.0		10.27	88.17	
0+47	47.0		10.34	88.10	Thalweg
0+48	48.0		10.32	88.12	
0+50.3	50.3		10.24	88.20	Right wetted channel
0+52.3	52.3		9.20	89.24	
0+54.2	54.2		8.81	89.63	
0+56.7	56.7		7.93	90.51	
0+62	62.0		6.89	91.55	Bottom of sidewalk

Appendix E: Raw Survey Data - Cross Section 4 at Station 1+65					
STATION	DISTANCE	BACKSHOT	FORESHOT	ELEVATION (2005)	DESCRIPTION
		7.22		90.47	Top of downstream culvert
0+00	17		0.09	97.6	Top of left bank
0+19	19		1.15	96.54	
0+29	28.6		5.47	92.22	
0+32	32.6		7.04	90.65	
0+35	35.1		8.5	89.19	
0+36	36.2		8.85	88.84	
0+37	37.3		9.62	88.07	
0+38	37.7		10.62	87.07	Left wetted channel
0+39	39.4		10.69	87	
0+40	39.6		11.02	86.67	Thalweg
0+41	40.5		10.97	86.72	
0+42	41.6		10.67	87.02	
0+43	43.4		10.55	87.14	Right wetted channel
0+44	44.2		10.03	87.66	
0+45	45		9.35	88.34	
0+50	49.1		8.74	88.95	
0+54	53.7		6.71	90.98	
0+56	56.3		5.55	92.14	
0+61	61.2		4.57	93.12	Top of right bank/sidewalk